agricultural research

U.S. DEPARTMENT OF AGRICULTURE AUGUST 1978

agricultural research

August 1978/Vol. 27, No. 2

The Promise of Guayule

GUAYULE is a desert shrub that has a history as fascinating as its potential is promising.

When the Spaniards arrived in the 16th century in what is now Mexico, they found the Aztec Indians playing a game similar to our basketball, but with a stone ring for a goal. Rubber for those balls came from guayule bushes, which grew wild in the arid, desert-like land. Indians chewed the stems of the bushes, separating the rubber from the rest of the plant material.

But even at that early time, guayule meant more than a basketball game. The rubber and resin in the plant burns fiercely, and was used as a fuel for the Indians' silver smelters. Later, in the beginning of this century, guayule became a source of natural rubber for more than a dozen factories in Mexico and Texas. By 1910, about half of all U.S. rubber came from wild guayule shrubs. Several industrial leaders invested $30 million in the Continental-Mexican Rubber Company, and harvested the wild guayule plants which were abundant in the Texas-Mexican border area.

But the extensive wild stands were soon depleted, and the country returned to the more cost-efficient process of extracting rubber from the Hevea rubber tree, commonly grown in the East Indies.

In 1930, the War Department considered the danger of the U.S. being cut off from its natural rubber supplies, most of which came from the Hevea tree in Malasia. Army Major Dwight Eisenhower was assigned to head a study of the less cost-effective guayule as an alternative. His report warned of the potential danger of a loss of our rubber supplies, and recommended that government-run guayule reservations be set aside for emergencies. His advice was ignored. Eleven years later, the U.S. lost more than 90 percent of its rubber when the Japanese invaded Southeast Asia.

A massive guayule emergency rubber project was begun, and produced 3 million pounds of rubber for the war effort. But after the war, the less cost-effective guayule was again forgotten, as the larger quantity of rubber in the Hevea plant made its production more efficient.

But that may be changing. Recent discoveries of the effect of certain chemicals called bioregulators on guayule have led scientists to take a serious, new look at the plant.

The implications of a cost-effective guayule plant are enormous. It grows in areas that support little or nothing else. Some of that land is the home of American Indians sorely in need of the opportunities a new industry, especially an agronomic one, would afford. A new guayule industry would be a boon to the economy and a lifesaver to the arid lands of the American Southwest.—*R.W.D.*

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COVER: Rubber yield from guayule plants is increased several times through the application of bioregulators—chemical compounds that can cause some plants to use more of their potential to produce a given product or trait than they normally would. Story begins on page 8 (0478X407–2A).

AGRICULTURAL RESEARCH is published monthly by the Science and Education Administration (SEA), U.S. Department of Agriculture, Washington, D.C. 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 15, 1982. Yearly subscription rate is $6.50 in the United States and countries of the Postal Union, $8.15 elsewhere. Single copies are 55 cents domestic, 70 cents foreign. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, D.C. 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by photo number.

Bob Bergland, Secretary
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James Nielson, Acting Director
of Science and Education

Biological technician Warren Blodgett inserts test cages of stored product insects at 2-foot elevation intervals in each of the five silo simulators. Researchers can then evaluate the effect of inert atmospheres at different storage depths (0575X583–15A).

In Stored Grain: No Oxygen - No Insects

PILOT-SCALE tests confirm that a technique for denying life-sustaining oxygen will control the major insect species infesting stored grain and unshelled nuts.

The technique involves displacing the normal storage atmosphere with the cooled exhaust from an exothermic inert atmosphere generator, a device used by industry in producing carbon black and in metal processing. The inert atmosphere is less than 1 percent oxygen and 9 to 9.5 percent carbon dioxide, with the balance principally nitrogen.

Decisions on where or when inert atmosphere control may be put to use will involve a careful weighing of available alternatives—their ability to kill insects, potential effects on food safety and the environment, energy requirements, and costs.

Charles L. Storey, an entomologist with SEA in Manhattan, Kans., first demonstrated feasibility of inert atmos-

phere insect control in field tests with two insects (AGR. RES., July 1973, p. 13). He now has identified time-temperature combinations for controlling all life stages of nine insects.

Inert atmosphere control could be a residue-free replacement for fumigation. An inert atmosphere contains only the nitrogen, carbon dioxide, and oxygen found in natural atmospheres—just in different proportions. Limited tests show no effects on quality or processing characteristics of wheat, rice, barley, almonds, and raisins.

Treatment time is longer than for fumigation. A 10-day exposure at 80° F. would be the minimum for controlling the most tolerant life stages of insect species likely to infest stored grain, Mr. Storey says. Initial investment cost probably restricts use of the technique to large bulk storage situations, and currently available generators would need adaptation to agricultural uses.

Energy for operating the generators is a big but possibly not insurmountable obstacle to application of inert atmosphere insect control. Mr. Storey suggests several as yet untested situations where alternate or multiple uses of energy, or tradeoffs between energy and environmental concerns, might be considered. Such alternatives might become more attractive if presently used fumigants were removed from the market for environmental reasons.

Studies with SEA entomologist Edwin L. Soderstrom, Fresno, Calif., show that the navel orangeworm in stored almonds can be controlled by less than 4-day exposure to an inert atmosphere. If an inert atmosphere were substituted for insecticides—which have potential residue problems and require energy for manufacture—energy use for refrigerated storage might be unnecessary.

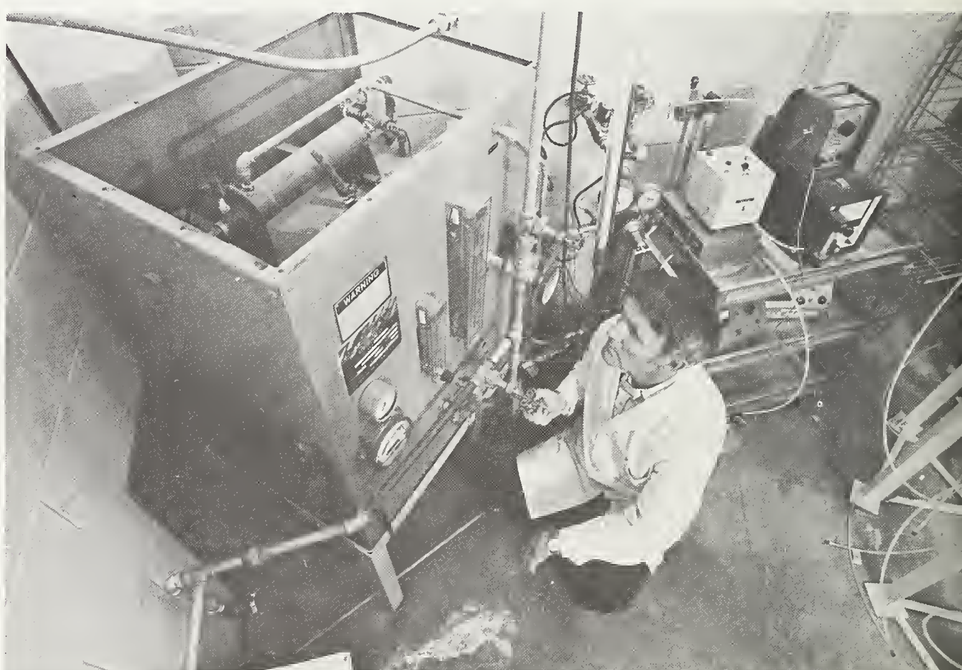
Shipboard insect control in containerized stored grain is another possibility. Fumigants are difficult to exhaust from ships' holds and a potential hazard to the crew, and ships have equipment similar to that needed for generating an inert atmosphere. Or, commercial elevators might make dual use of generators, with the heat diverted to crop drying and the exhaust used in insect control.

In studies with a laboratory-scale generator, Mr. Storey found that exposure time for 95-percent kill is influenced by insect species, atmosphere temperature during treatment, and life stage of the insect.

At 80° F., treatment time for adult insects ranged from 55 hours for granary weevils and 48 hours for rice weevils down to 17 hours for red flour beetles and 11 hours for sawtoothed grain beetles. Required exposure time declines as temperature is raised, Mr. Storey found. As an extreme example, adult rice weevils needed 296-hour exposure for 95-percent mortality at 60°, 200 hours at 70°, 48 hours at 80°, and 19 hours at 90°.

Another test indicated a more than five-fold difference in treatment time for 95 percent kill of different rice weevil stages, and a three-fold difference for the granary weevil. The greatest tolerance to inert atmospheres was generally in later larval stages through midway in pupal development. Newly emerged larvae, eggs, or adults were the most susceptible stages in species tested, which also included the confused flour beetle, Indian meal moth, almond moth, and angoumois grain moth.

Mr. Storey, with SEA scientists Ye-



Mr. Blodgett adjusts air flow meters for a temperature control chamber. Inside the chamber, generated inert atmospheres are passed through flow meters into jars containing stored-product insects at various life stages. In testing the effects of inert atmospheres on stored product insects, temperature controls are one major parameter; exposure time and insect life stages are others (0575X581–13A).

shajahu Pomeranz and Fang S. Lai, Manhattan, and Noel N. Standridge, Madison, Wis., also tested an inert atmosphere as a modified storage environment for continuous protection of bulk-stored barley and malt.

Six-month storage of Larker and Klages malting-type barley had no consistent effect on germination, kernel weight, plumpness, or kernel color. The researchers observed no adverse effects on malt produced from the stored barley; they also found that commercial brewers' and distillers' malts can be safely stored 12 months in inert or airflow atmospheres.

Mr. Charles L. Storey is at the U.S. Grain Marketing Research Laboratory, 1515 College Ave., Manhatten, KS 66502.—*W.W.M.*

Mr. Storey adjusts flow rates to approximately 25 cubic centimeters per minute—enough pressure to prevent normal air from seeping into the jar. Inert air tests are also run for commodities at different storage temperatures (0575X583–25A).

Doubled Wheat Yields

Of the world's estimated 3¾ billion acres of land that are used for cultivated crops, only approximately 11 percent are currently irrigated.

Most developed countries are already diverting as much water for agricultural use as possible. Developing countries either lack capital or know-how for such vast undertakings.

For these reasons, SEA is looking for methods to utilize every available drop of precipitation that falls or is already in soils.

At the U.S. Central Great Plains Research Station, Akron, Colo., SEA scientists have analyzed data from 1916 to the present. These records show that proper soil management can more than double wheat yields on dry lands.

From 1916 to 1930, precipitation at Akron averaged 17.3 inches per year and wheat yields averaged 15.0 bushels per acre. In the 1970's, improved management practices more than doubled wheat yields to 32.2 bushels per acre—and that's during a period that averaged 15.3 inches annual precipitation.

"Part of this yield increase is undoubtedly due to new and improved wheat varieties. However, the greatest increase is attributed to improved soil management practices that have increased soil-water storage during fallow," say SEA soil scientists Darryl E. Smika and Bentley W. Greb.

Fallow is the period during which agricultural land is left unseeded. During this time, soil moisture is stored from the precipitation received. This stored moisture is then available for the next crop.

The two practices during fallow that are necessary for increasing soil moisture storage are weed control and the maintenance of mulch on the soil surface.

"Our research shows that the best way to maximize wheat production on these areas is by controlling *all* weed growth during the entire fallow period. Even a few weeds per square yard remove water that the subsequent crop must have.

"Also, maintaining stubble from the previous crop in a standing position during the over-winter portion of fallow provides an excellent means of trapping and holding snow. Then during spring thaw, the snow melts into the soil and agricultural lands, not into ditches or fence lines," says Greb.

Soil moisture gained from snow melt amounts to approximately 40 percent of that stored in soil during fallow.

Maintaining a surface mulch on the soil aids in moisture retention both by decreasing soil temperature and by diverting drying winds to a level above the soil surface.

Dr. Darryl E. Smika and Mr. Bentley W. Greb are with the Central Great Plains Research Station, P.O. Box K, Akron, CO 80720.—*D.H.S.*

Conserving Nitrogen for Corn

Some 400,000 cubic feet of natural gas is required to manufacture 1 ton of ammonia (NH_3), which is either applied directly to farmland or converted into other forms of fertilizer. A savings of 13 pounds of nitrogen (N) per acre on 500 acres of midwestern claypan soil would save energy equivalent to the amount of natural gas that it takes to heat a typical home in a climate like that of Peoria, Ill. for 1 year.

Another benefit from N conservation may be reduced risk of water pollution. Water with concentrations of 10 parts nitrate-N per million, when consumed by babies may cause methemoglobinemia or "blue baby disease." Views differ on whether nitrogen fertilizers are

FARMERS who grow no-till corn on midwestern claypan soils can conserve expensive nitrogen fertilizer without sacrificing yield. At the same time, farming methods that make this possible may also help reduce nitrogen pollution in streams and ponds, control erosion, and curb use of vast amounts of energy that are required for producing the Nation's fertilizer.

A team of SEA scientists conducted research near Columbia, Mo., which showed that rate of fertilizer application, time of application, and fertilizer placement affected efficiency of nitrogen use by corn crops. The study was done on land that is similar to some 10 million acres of the Corn Belt.

The ability of midwestern claypan soils to absorb rainfall is low compared to many other more permeable soils, says soil scientist Robert E. Burwell. Consequently, much of the rain runs off cropland, carrying with it soil, nitrogen, and other plant nutrients.

Research leader Herman G. Heinemann and hydrologic engineering technician Fred D. Whitaker, now retired from SEA, initiated the N–fertilizer study and decided that runoff losses of nitrogen might be reduced greatly if surface applications of fertilizer could be avoided. Mr. Whitaker modified a planter to plant both no-till and conventionally tilled corn and to apply granular fertilizer as starter some 4 to 5 inches deep near corn rows.

The researchers also used the modified equipment to band 34 to 102 pounds of N as sidedressing at a depth of 4 to 5 inches. This was done when the corn was 10 to 12 inches tall. It is then, 5 or 6 weeks after planting, that corn starts to use large amounts of nitrogen, Mr. Burwell says.

Fertilizing corn at various rates for 3 successive years, the researchers studied nitrogen losses and yields from no-till plots that received the well-placed and well-timed fertilizer applications. On conventionally tilled plots used for comparisons, some fertilizer was plowed under in the spring and the remainder was banded into the soil as starter and sidedressing.

At fertilizer rates above 189 pounds nitrogen per acre, the no-till corn generally outyielded conventionally grown corn. At lower rates, the conventionally grown corn generally outyielded no-till corn.

No-till plots which the researchers fertilized at a rate of 325 pounds nitrogen per acre yielded about 22 bushels more corn per acre than no-till plots fertilized at the 189 pound rate. But the heavily fertilized corn lost 31 pounds of nitrogen per acre per year in runoff and eroded soil as compared to 18 pounds of nitrogen for the moderately fertilized no-till corn.

Conventional plots that were fertilized at the 189 pound rate also lost 31 pounds of nitrogen. Conventional plots that were fertilized at the 325 pound rate lost about 50 pounds of nitrogen in runoff and eroded soil and they produced no more corn than plots fertilized at the 189 pound rate.

"Considering current prices of corn and nitrogen as well as the potential for pollution of lakes and streams, we do not recommend the higher fertilization rates," says Mr. Burwell. Excess N may not only be lost in runoff and enter surface water supplies but some of it may also leach through the soil and enter underground water supplies. In addition, large quantities of N may be lost to the atmosphere before it can be utilized by crops, he says. because un-

increasing, measurably, the nitrogen content of surface and subsurface waters. Some scientists have expressed concern that continued increases in fertilizer use will result in widespread buildup of nitrates to intolerable levels in waters. Research described in the accompanying article provided data that may support a view that proper nitrogen fertilization is not likely to seriously undermine water quality on moderately sloping claypan soils. However, the quality of runoff water from claypan-like soils can be measurably affected when farmers apply uneconomically high rates of N fertilizer on conventionally tilled fields or when the fertilizer is applied several weeks before major crop use.

der warm, wet soil conditions large amounts of applied N fertilizer may be converted to gaseous forms by bacteria.

In the study, soluble N, or nitrogen that plants could use, comprised a substantial portion of the N lost in runoff from both no-till and conventional corn. But organic N, which tends to be insoluble, was lost in great quantities only from conventional plots. Organic forms of N were mostly transported with eroded soil.

Mr. Burwell noted that topsoil loss from conventionally tilled corn was about 5 times greater than topsoil loss from no-till corn. Consequently, future productivity of the conventionally tilled land may be impaired if erosion is permitted to continue, he says.

Soluble nitrogen impaired the quality of water that flowed from conventional corn more than it impaired the quality of water from no-till corn.

Mr. Herman G. Heinemann is with the USDA Hydrograph Laboratory, BARC–West, Bldg. 007, Room 139, Beltsville, MD 20705.—*G.B.H.*

European Parasite Laboratory

THROUGH the development of international commerce, America's agriculture has been subjected to many foreign insect pests which have damaged crops, forests and livestock.

These insects have successfully adapted to our lands as they arrived without their own enemies—parasites and predators.

The U.S. Department of Agriculture organized a program in 1889 to reduce the incidence and destruction of these insects. Since then, USDA entomologists have been searching world-wide for the natural enemies of these pests for introduction into our agricultural environments.

The first permanent foreign outpost for the collection and shipment of insect parasites and predators to the United States was the USDA's European Parasite Laboratory (EPL) set up in Auch, France in 1919.

Originally assigned to look for the natural enemies of the European corn borer, the EPL rapidly developed into one of the world's most important biological control laboratories and is now administratively served by the International Programs Staff of SEA.

The European Parasite Laboratory has shipped hundreds of thousands of insects to the U.S. In 1976 and 1977 over 50,000 beneficial insects representing 40 different species were air shipped to the U.S. for use against various pests such as the gypsy moth, greenbug, lygus bug, alfalfa leaf miner, aphid, and bark beetle.

One of the EPL's successful attempts at biological control was the alfalfa weevil project. Four European parasites of the weevil were shipped by EPL to the U.S. and were established in areas of the middle Atlantic states, where they are now contributing to the decline of the alfalfa weevil.

The estimated initial cost of the program in Europe and at the USDA quarantine headquarters in Moorestown, N.J. (now in Newark, Del.) was $600,000. But in 1970 alone, by not having to apply other treatments, the project resulted in a $3,000,000 savings to farmers in those states where the weevil's natural enemies were introduced.

From its headquarters in Sevres, a suburb of Paris, the EPL entomologists travel throughout Europe, the Middle East and North Africa in their search for natural enemies of our most damaging pests. Because of the international nature of its work, the EPL cooperates with many of the world's entomologists and entomology institutes in an exchange of ideas and techniques, facilities, and living cultures.

The EPL has a professional staff of American and French entomologists, technicians and support personnel. Staff entomologists are Americans Dr. John J. Drea and Dr. Robert C. Hedlund and France's Mr. F. Hérard and Mr. F. Gruber.—*M.A.M.*

New Method Increases

Right: *Dr. Yokoyama (left) and cooperating Los Angeles County Arboretum plant anatomist Indira Mehta discuss anatomical changes in guayule due to treatment with bioregulators. Changes in plant anatomy are an integral part of the bioregulation process; however, scientists have found no evidence to support the possibility of corresponding genetic mutations—i.e., they have found no changes in the hereditary characteristics of a treated plant (4078X401–20A).*

Bioregulators are chemical agents which enable scientists to manipulate the biosynthesis and metabolic pathways of plant cells. Although bioregulators probably exist in nature, their laboratory synthesis is necessary because naturally occurring ones have not as yet been detected. Here, SEA chemist Stephen Poling synthesizes a bioregulator (0478X405–24A).

Above: *Here, SEA Chemist Stephen Poling sprays bioregulators on guayule plants. The chemicals increase the amount of rubber in the plants (478X403–27A).*

A CHEMICAL method of dramatically increasing the yield of rubber in the lowly desert shrub guayule opens an avenue of producing that scarce commodity commercially in this country.

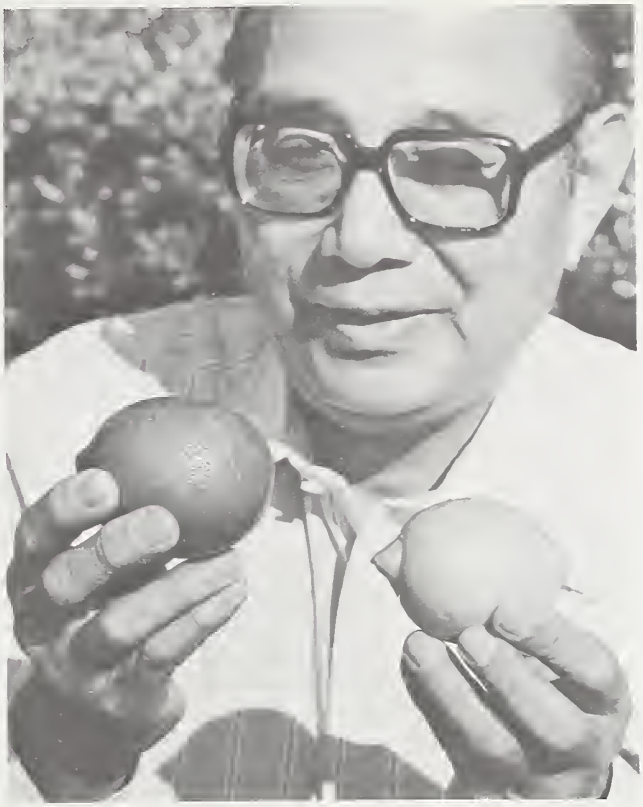
The plant is sprayed with compounds called bioregulators—mixtures of low-cost chemicals—about 3 weeks before harvest, and the mysteries of chemistry take over to produce from 2 to 6 times the "normal" yield of rubber in young plants.

The compounds are a group of organic substances called triethylamines. One of them, 2-(3,4-dichlorophenoxy,-triethylamine), seems to work better than the rest.

SEA chemist Henry Yokoyama of the Pasadena Fruit and Vegetable Chemistry Laboratory, says the compounds work by causing the plants to express genetic traits more efficiently. Rubber producing cells in the guayule plants become more active and produce more rubber.

Guayule plants (pronounced wy-ool-ee) normally yield about 500 pounds of rubber per acre, not enough to support an industry. One thousand pounds per

Rubber From Guayule



Above: *Rubber from lemons? Not quite, but discoveries by Dr. Yokoyama on the bioregulation of color in citrus fruits led him directly into research on rubber yield in guayule plants. Carotenoid compounds, which determine the color of these lemons, have "building blocks" similar to those that produce rubber in guayule; the blocks fit together differently in the guayule plant, but their chemical composition is the same. By chemically stimulating the building blocks for the carotenoid compounds, more red—i.e., a red lemon—is produced. The same chemicals applied to a guayule plant result in more rubber. Dr. Yokoyama, here comparing a red (darker) lemon to one not treated with a bioregulator, has directed over 90 percent of the world's research in the field of bioregulation (0478X408–17A).*

acre could, Dr. Yokoyama says.

Guayule is native to Mexico and Texas but some 5 million acres of land that could support its production is available in New Mexico, Arizona, and California.

Guayule is not grown commercially anywhere although a small industry in Mexico is sustained by harvesting the shrub in its wild state. During World War II. an experimental study called the Emergency Rubber Project spent around $30 million and planted some 32,000 acres of guayule in the Salinas Valley of California, in an effort to find an alternate source of rubber. That project was scrapped with the development of synthetic rubber, but not before a wealth of information on the plant was gathered.

Dr. Yokoyama says his project may be as much as 3 years away from commercial feasibility because field trials must be conducted to bolster his laboratory findings.

Natural rubber may become increasingly harder to come by. Leaf blight in Brazil all but stopped production there. and older trees in Malaysia and Southeast Asia are being replaced with other more profitable palm oil plantings.

Petroleum, from which synthetic rubber is made, is rising in price and could become more and more expensive. In 1977. the U.S. imported more than 875,000 metric tons of rubber at a cost of about $800 million.

The introduction of a "new" agricultural crop (guayule was known by the Indians of Mexico before the arrival of the Spanish) in the areas where guayule can be grown would be a boon to

New Method for Guayule

Above: *SEA chemist Ernst Hayman grinds guayule plant material slated for analysis through nuclear magnetic resonance (0478X404–21A).* **Right:** *Spectra tracings generated by the resonator are studied by Dr. Hayman in order to assess the amount of latex sap in the guayule (0478X406–7A).*

Indians of the region providing employment and a use for some of their lands that can grow little else.

Research shows that deresinated guayule rubber, protected by antioxidants, is equal in every respect to tree rubber. Commercially valuable by-products of the plant include bagasse (wood fiber), resins, and leaves. For each ton of rubber, guayule produces about 2 tons of bagasse, a half ton of resins and about a ton of leaves. Bagasse may find possible use in paper pulp manufacture. Resins contain volatile and nonvolatile terpenids, a high melting wax, a shellac-like gum, drying oils and cinnamic acid. Leaves contain a valuable hard wax with a melting point higher than carnuba generally thought of as "the best." Guayule leaves produce large quantities of this clear, white, easily extracted wax.

Guayule is a member of the sunflower family and is a hardy woody perennial shrub with silver-gray leaves. It is usually less than 3 feet in height and has been harvested after 2 or more years of growth. Under favorable conditions, after 4 years of growth, guayule plants may contain more than 20 percent rubber on a dry weight basis. Dr. Yokoyama says his process could increase the yield to about 30 to 35 percent and cut the growing time by about a year or two.

Successful plantations have been established from nursery grown plants or by direct seeding in the field. Since rubber is found in recoverable quantities in much of the plant, other than the leaves, harvesting has involved digging out the entire shrub or sometimes clipping upper portions to allow for the generation of new growth. Dr. Henry Yokoyama is with the Fruit & Vegetable Chemistry Laboratory, 263 S. Chester Avenue, Pasadena, CA 91106.—*J.P.D.*

Crop Residues— —Not A Waste

A FARMER in the Northern Great Plains must integrate three elements to maintain consistently high crop production: soil-water storage, weed control, and soil fertility.

Residue management is involved in all three, soil scientist James F. Power says. Residues affect water conservation by altering water infiltration rates, evaporation and runoff, and by trapping snow. Residues determine to a large degree the nature and size of the weed population and dictate the weed control measures required. And, residue management greatly affects the amount of plant nutrients tied up in residues and the rate at which these nutrients are released for plant growth or lost by leaching or volatilization.

Removal of crop residues for industrial use or other purposes could reduce the opportunity to conserve water, affect weed populations, and increase fertilizer requirements. Dr. Power says these results must be considered when decisions are made concerning crop residues.

Dr. Power, stationed at the Northern Great Plains Research Laboratory, Mandan, N.D., says the quantity of nutrients temporarily immobilized each year in chaff, straw, stubble, and roots probably equals or exceeds the nutrients removed in the grain. A 30-bushel wheat crop therefore contains about 50 pounds of nitrogen per acre in grain, and leaves about the same amount in the field in residues after harvest.

"In our northern climate, several years are usually needed to break down residues and release the nutrients," the soil scientist says. "This means that the amount of nutrients tied up in partially decomposed residues at any one time may be several times the amount returned annually. A soil capable of producing a 30-bushel wheat crop may have more than 100 pounds of nitrogen immobilized in various forms of plant residues."

If you remove the residues you will have to increase your fertilizer applications, and therefore the energy required to produce, transport, and apply that additional fertilizer.

Management systems may reduce the nutrient reservoir by removing straw for bedding or other uses, by using a summer fallow cropping system, and by other practices that reduce the total amount of residue returned to the soil over a cropping cycle.

"The size of this reservoir probably has a much greater effect on the amount of nutrients made available to the growing crop than any other management factor," Dr. Power stressed. "Continued removal of residues leads eventually to a depletion of this nutrient reservoir and to a very infertile soil."

"Widespread industrial use of crop residues could result in soil deterioration and destruction of soil resources, as is seen in North Africa, the Near East, and Korea. There, few organic residues or fertilizers have been returned to the soil," Dr. Power added.

Incorporation of residues into the soil usually hastens residue decomposition and nutrient turnover. Leaving residues on the surface usually results in slower decomposition and a greater accumulation of partially decomposed residues.

Dr. Power points out that residues on the soil surface insulate the soil, reducing daily maximum soil temperatures near the surface. This change can directly affect seed germination, stand-establishment, and plant growth rates. Most important in the moisture-short Great Plains, the lowered temperature results in a reduction in evaporation rate and greater water retention in the surface soil.

Other research shows that after several years of leaving high quantities of wheat straw on the soil surface both available nitrogen and phosphorus in the soil may be increased.

This indicates that no-till systems may eventually provide a higher level of inherent soil fertility than those systems in which residues are buried because a larger nutrient reservoir is established. However, Dr. Power says that fertilizer requirements for no-till systems may be as high or higher than those for other residue management systems because yield potential is often greater as a result of better water conservation. Additional water allows greater plant growth which increases fertilizer needs.

Each combination of crop, soil, and climate has its own distinctive set of needs for residue management and fertilizer practices to provide the "ideal" available nutrient profile during the growing season, Dr. Power says.

"This points to the need to develop specific data for land resource areas having similar soils, climate and land use practices. Considerable research and development is still needed to perfect the ideal residue management system for the Northern Great Plains," Dr. Power added.

Dr. James F. Power is with the Northern Great Plains Research Laboratory, P.O. Box 459, Mandan, ND 58554.—*R.G.P.*

Promising Peanut Proteins

WORKING for peanuts can be exciting. This is especially true when research on peanuts leads to findings that can help improve the nutrition of a nation.

Vegetable proteins have been used in foods for a number of years, and chemical modification of the protein is often necessary to produce more desirable properties.

To achieve such properties—solubility, emulsifying capacity, whippability—the proteins are partially hydrolyzed, most often with acid or alkali, and occasionally with enzymes. Enhancing these properties would increase the use of the peanut protein in foods such as puddings, dessert toppings, salad dressings, and sauces.

Hydrolysis by either acid or alkali requires the final product be neutralized which increases the concentration of salt. Use of the high-salt hydrolyzates must be restricted where high concentrations of salt are undesirable, such as low-salt diets.

A serious deterrent to the wider use of protein hydrolyzates in food systems is the development of bitterness caused by excessive or uncontrolled hydrolysis of the protein. Hydrolysis is a chemical reaction that breaks the large protein molecules into smaller units. If uncontrolled, hydrolysis breaks protein down too far—into peptides and amino acids which induce bitterness. This makes the product undesirable for food use.

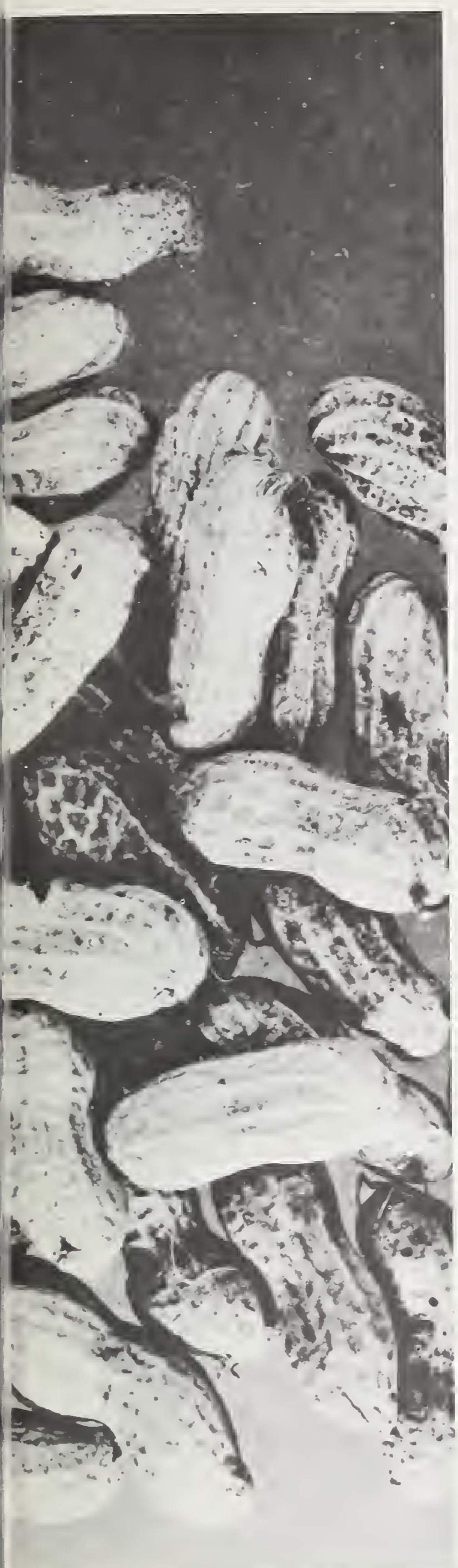
What the SEA scientists have done is find a self-limiting way to partially hydrolyze peanut protein. That is, the chemical reaction goes just so far and stops—and it stops short of developing bitterness.

The secret is in the hydrolyzing agent, papain, an enzyme obtained from the juice of the papaya plant. When introduced to a water slurry of peanut protein, it immediately goes to work, partially hydrolyzes the protein and stops.

Interestingly enough, the papain isn't even spent when it completes its work. If more protein is added to the already partially hydrolyzed batch, the enzyme will go to work on the new material until it reaches a certain point, and then it stops.

This feature of the enzyme makes it even more attractive as a hydrolyzing agent. The scientists suggest that it can probably be bound to an inactive solid and used over and over again. These systems are referred to as immobilized enzymes and are being used in other processes. The research team has not tried papain as a hydrolyzing agent for soybean protein but did try it on cottonseed proteins. Cottonseed proteins are much less soluble in a water slurry, however, so that the amount of protein hydrolyzed was less than that for peanuts.

The research was conducted by Dr. Antonio A. Sekul and Dr. Robert L. Ory at the Southern Regional Research Center, P.O. Box 19687, New Orleans, LA 70179.—*V.R.B.*



Insecticide Increases Peanut Yields?

PEANUT growers in the southeastern peanut belt who apply disulfoton at planting time may experience yield increases due to an unexplained phenomenon—the systemic insecticide appears to act as a mild growth regulator for peanuts.

During recent years, the intensity of pesticide usage on peanuts has greatly increased and many researchers and extension specialists have been concerned about the effects the pesticides may have on the newer high yielding cultivars.

SEA and other scientists have conducted a series of experiments to determine what, if any, genetic vulnerability may result from an interaction between peanuts and the various pesticides used to protect them. The ongoing research has been conducted over 4 years with three cultivars, with the aid of university and Agricultural Experiment Station scientists from Alabama, Florida, and Georgia.

The experiments were conducted on five soil types: Dothan sandy loam, Greenville sandy clay loam, Ocilla sandy loam, Tifton sandy loam, and Ruston loamy fine sand.

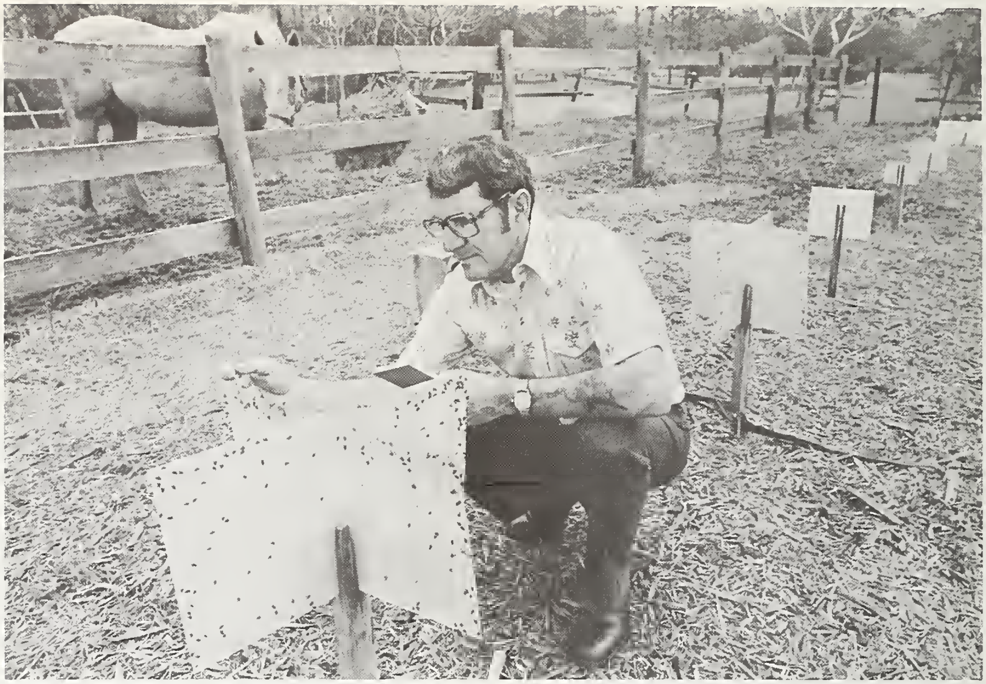
In early experiments with disulfoton, the insecticide caused an average increase of 59 kilograms per hectare (kg/ha), but the reaction of the cultivars was inconsistent. For example, in four of six comparisons, Florunner yielded more when treated with disulfoton; it increased the yield of Tifspan twice but had no effect on the yield of GK 3, a new variety. In later experiments, where Florunner was the only cultivar used, disulfoton increased the average yield of peanuts by 120 kg/ha.

An interaction occurred between the insecticide and soil types. In the 14 interaction experiments conducted thus far in the research, the yields of Florunner (the most widely grown cultivar) were increased 60 percent of the time, but in no case did an increase occur on a Dothan soil.

Although average yields increased with the use of the systemic insecticide, just the opposite occurred with the use of intensive herbicide treatments: yields, on the average, were somewhat depressed.

The research is not yet complete, but results thus far indicate that multiple applications of herbicides often reduce yields. For example on a Tifton soil, highest yields occurred without benefit of herbicides, and yields were almost as high when only vernolate was applied as a preplant incorporated treatment.

The research is being conducted under the leadership of SEA agronomist Dr. Ellis W. Hauser at the Coastal Plain Experiment Station, Tifton, GA 31794.—*V.R.B.*



Field tests were conducted to determine how much surface area was necessary—and most efficient. Technician Richard Fye counts flies captured within 24 hours of trap placement (0378X281–15).

Fiberglass: Irresistable to Flies

PYRETHROID-TREATED translucent fiberglass can catch more flies than honey. Or so it would seem from tests conducted with a unique attractant-toxicant system to control stable fly populations.

Stable flies, *Stomoxys calcitrans*, a principal pest of both people and animals, are currently controlled by sanitation, waste disposal, and pesticides. Insect growth regulators, parasites, and sterile male releases can provide additional methods of suppresion.

In studies to determine stable fly density, a trap is used consisting of two fiberglass panels (Alsynite), 28 by 45 cm. Both are treated with an adhesive material, and are interlocked vertically at right angles at the center and mounted 50 cm above the ground on a stake. These traps are highly effective when used in breeding and resting sites.

This trap, called the Williams trap after its originator, Dr. David Williams, attracts stable flies very strongly—in fact, so strongly that scientists have become interested in its potential for actual control of the flies.

The adhesive has the disadvantage of masking or reducing the attractant surface with hundreds of trapped insects. By substituting the pyrethroid compound permethrin for the adhesive, scientists hoped to kill stable flies by momentary contact with the panels.

In outdoor cage tests with a treated trap, 2,000 laboratory-reared flies were released into the cage and were killed within 24 hours. Increasing the permethrin from 0.5 grams per square meter (g per m^2) to 2.5 g per m^2 produced more than 99 percent kill of the flies within 24 hours, extending the effectiveness over a 6-week period.

Ninety percent of 1,000 stable flies in a cage with permethrin traps were killed within 4 hours, but with the Williams trap only 60 percent of 1,000 were caught on the adhesive.

To determine the period of field effectiveness, the panels, treated with 2.5 g per m^2 permethrin, were exposed to the elements for 6 weeks. Then once a week the scientists placed them in outdoor cages with stable flies. Panels killed 95 to 100 percent of the flies in 24 hours for periods ranging from 2 to 6 weeks.

"With this background data," says entomologist David W. Meifert at the Insects Affecting Man and Animals Research Laboratory, "we were ready for more practical field trials with the permethrin-treated units. We chose the Beef Research Unit of the University of Florida, which has a small herd of 13 cattle confined in feed lots, and a large poultry installation in Chiefland that had a herd of 25 cattle in nearby pasture."

At the Beef Research Unit the droppings from the cattle pens were washed into an adjoining ditch where stable flies bred. Three treated units were placed next to the breeding area and the confined animals. In Chiefland five treated units were placed 10 m apart near the area where the cattle came for water.

At each of the sites 84 to 97 percent reductions in stable fly density were

Technician Troy Whitfield applies a commercially-available adhesive to fiberglass trap (0378X282–5).

realized within 7 to 11 days.

"The laboratory and field tests demonstrated that the attractant-toxicant system was potentially useful for stable fly control because it attracted and killed a sufficiently large proportion of the total population of adults to cause rapid reduction in both areas," says entomologist Richard S. Patterson. "The response of the adult population in the field was actually greater than 30 percent per day."

The attractant-toxicant system is a practical, non-contaminating, safe approach to the control of this economically important pest.

One puzzle remains. Why is the fiberglass attractive? So far only the flies know.

Other members of the research team were technician Troy Whitfield and entomologists Germain C. LaBrecque and Donald E. Weidhaas.

Mr. David W. Meifert is with the Insects Infecting Man and Animals Research Laboratory, 1600 S.W. 23rd Drive, P.O. Box 14565, Gainesville, FL 32604.—*P.L.G.*

Bigger Lambs With Birdsfoot

LAMBS on a pasture system with birdsfoot trefoil showed a 23 percent higher rate of gain by the end of the grazing season than did lambs on alfalfa-grass pasture systems without trefoil.

Increasing the proportion of legumes in grazing systems increases the energy intake of ruminants and produces faster weight gains. The question has been how to do it without the bloat problems that often occur when lambs graze a legume, particularly alfalfa.

"The answer may be increased use of long unappreciated birdsfoot trefoil, which does not cause bloat," research agronomist Gordon C. Marten says. A research leader with SEA at St. Paul, Minn., Dr. Marten worked with animal scientist Robert M. Jordan of the University of Minnesota staff through three pasture seasons.

They pastured lambs on four different systems with alfalfa-grass combinations. Two systems included pure birdsfoot trefoil for one-third of the pasture season.

One non-trefoil-system was a full pasture season on a mix of alfalfa-bromegrass-orchardgrass. The other was a pasture sequence of alfalfa-orchardgrass, alfalfa-reed canarygrass, and alfalfa-bromegrass.

In both of the birdsfoot trefoil pasture systems, the lambs spent two-thirds of the season on an alfalfa - bromegrass - orchardgrass mix. In one test the lambs went on a pure trefoil pasture for three of nine equal periods of the pasture season. In the other test, mature trefoil was grazed for two long periods combined with seven shorter periods on alfalfa-grass.

The lambs on both of the trefoil systems averaged 23 percent more weight by the end of the grazing season than lambs on the alfalfa-grass mixtures.

"It has been widely believed that the poor yielding ability and slow spring growth of birdsfoot trefoil makes alfalfa-grass mixtures a better crop where soils are good enough to support alfalfa," Dr. Marten says.

"But the increase in production of pounds of meat per animal in this test more than offsets the lower carrying capacity of trefoil compared to alfalfa-grass pastures," Dr. Martin says. He recommends that birdsfoot trefoil comprise one-third of the total pasture area for quick production of marketable lambs.

If pastures are to be established in areas where perennial weeds are a problem, Dr. Marten advises seeding a small amount of a noncompetitive grass with the birdsfoot trefoil to fill in spaces that will develop with time, preventing weed invasion and the need for renovation. A slow-starting, warm-season grass such as switchgrass is best for this purpose (the objective is to prevent weed encroachment while keeping the maximum percentage of legumes in the stand).

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MIDT Test

A NEW diagnostic test is as sensitive as the virus neutralization (VN) test in general use for detecting pseudorabies antibodies in swine serum in early stages of infection.

The microimmunodiffusion test (MIDT), developed in 1977 at the National Animal Disease Center, was previously shown to be as sensitive and specific as the VN test. But it is simpler, faster, and less expensive to perform.

Additional research shows the MIDT accurately detects low levels of antibody to pseudorabies virus antigens within a week after experimental exposure. Cytotoxic properties of some swine blood serums sometimes make these low levels difficult to detect with the VN Test.

Early detection is essential in the control and eventual eradication of pseudorabies, also known as Aujeszky's disease. In susceptible suckling pigs, pseudorabies virus infection may produce acute inflammation, paralysis, coma, and death within 24 hours of onset.

SEA microbiologist Eugene C. Pirtle and veterinary medical officer Donald E. Gutekunst experimentally exposed 18 pigs weighing 20 to 24 pounds to a pseudorabies virus of relatively low virulence. The researchers isolated the virus from nasal passages of all 18 pigs 7 days after exposure; they isolated the virus from only two on the 14th day, and none on the 21st day.

Both tests detected pseudorabies virus antibodies on the 7th day after exposure when levels were very low, as well as on the 14th and 21st days when antibody levels were generally higher. The VN tests were repeated on three occasions, mainly to distinguish VN antibody from cytotoxicity in the low dilutions of serum.

Drs. Eugene C. Pirtle and Donald E. Gutekunst are at the National Animal Disease Center, P.O. Box 70, Ames, IA 50010.—*W.W.M.*

Research Aids Horses

SEA VETERINARIAN R. Keith Farrell's freeze-marking technique and Angle System of animal identification (AGR. RES. Feb., 1975, 9 pp.) is now being used in the Federal Government's "Adopt-a-Horse" program. This means, for the first time ever, that horses can be transported across state lines without losing their "official" identity.

Sponsored by the Bureau of Land Management of the Department of the Interior, "adopt-a-Horse" is a program in which wild horses and burros are cared for by private citizens. The idea is to reduce the number of animals feeding on the open rangeland.

Since ownership is retained by the Federal Government, the animals are marked to prevent them from being sold, traded for commercial purposes, or otherwise disposed of illegally. The Federal marking takes precedence over any state identification records.

Prior to the "Adopt-a-Horse" program, state identification records prevailed and a horse could not be transported across state lines without acquiring a new set of identification records. This new program could pave the way for a nationwide and, perhaps one day, a worldwide horse identification program.

Dr. Farrell's Angle System—a system of right angles and bars—will be used to identify an individual animal and specify the state and district in which it was captured. The identification markings will be placed on the left side of the neck using Dr. Farrell's freeze-marking technique.

The Angle System was chosen because it offers simplicity, preciseness and universal application; it readily lends itself to a computerized data retrieval system and, above all, it provides good visual communication. Freeze-marking is being used instead of fire branding because its marks are more distinct and last just as long; no open wounds are produced; and freeze-marking is relatively painless.

Dr. R. Keith Farrell is located at Room 202, Wegner Hall, Washington State University, Pullman, WA 99164.—*L.C.Y.*

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